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ScienceDirect
Energy Procedia 61 (2014) 203 – 206
Energy Procedia

The 6th International Conference on Applied Energy – ICAE2014

Econometric Analysis of the Causality between Energy Supply and GDP: The Case of Malaysia

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Abstract

This study investigates the causal interplay between four major domains of energy supply i.e., oil, petroleum, gas and coal and economic growth (GDP) in Malaysia. For this purpose, cointegration, Granger causality and variance decomposition tests have been applied. The major findings extract from this paper are as follows: *(1)* Long run relationships are detected between GDP and energy supply (in oil and coal types). *(2)* Short run unidirectional causality exists running from GDP to energy supply (petroleum and gas) while long run causality was detected from oil and coal towards GDP. *(3)* The results of the variance decompositions suggest that the impact of GDP to energy supply become noticeable only over the longer period of time, implying that energy saving measures can smooth the path of economic growth in the long run. In order to sustain long term growth, it is necessary to increase investment in supply of energy and technology progress while at the same time increase the efficiency in energy usage for the country. This could strike the balance of environmental concern, economic growth, sustainability and energy security for Malaysia.

Peer-review under responsibility of the Organizing Committee of ICAE2014

Keywords: Energy Supply, Economic Growth, Energy Security, Causality, Variance Decomposition

1. Introduction

Malaysia, with a GDP of RM 765,965 million [1] and real GDP growth of 7.2 percent in 2010 [2], is one of the developing countries in ASEAN. Looking into the energy sector, the demand and supply in Malaysia has increased rapidly in past decades [3, 4, 5]. Most of the energy sources in Malaysia originated from oil, petroleum, coal, natural gas and renewable energy where the fossil fuels (oil, petroleum, natural gas and coal) contribute about 98 percent of the total primary energy supply in 2010 [5].

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Peer-review under responsibility of the Organizing Committee of ICAE2014
doi:10.1016/j.egypro.2014.11.1065

This scenario provide an indication that the country is facing crucial challenge in terms of energy security and reliability of energy supply. According to Islam et al. [4], diverse energy resources are pertinent for Malaysia so that the dependency on a single source of energy (fossil fuels), could be uplift in which is in line with the Four (Five) Fuel Diversification Strategy 1981 (1999). This notion proves that dependency on fossil fuels were still the mainstream key elements for economic growth in Malaysia. As the scenario persists, alternative, form of energy would mitigate this issue, which have emerged as important components of world energy consumption in the past decade[1].

Despite having natural resources, such as oil, petroleum, natural gas and others, Malaysia do import energy sources from the neighbouring countries. For example, based on the data from MEIH [5] net import for petroleum in 2010 stand at 1928 ktoe, an overturn from positive value in 2009 (net export). Net import for both natural gas and coal increase about 45 percent in 2010 as compared to last year's net import [5]. For oil domain, the value of net export is on decreasing trend. Further, Oh et al. [7] and Khor and Lalchand [8] indicate that Malaysia would gain the net importer '*status*' by year 2030. Against this background, identifying the relationship between energy-GDP is rather paramount, in which proper policy framework is in need to ensure sustainability and security of energy supply for Malaysia.

With the motivation in place, the primary purpose of this paper is to investigate the causality interplay between four main domains of energy supply and gross domestic product (GDP) in Malaysia from 1978 to 2010. The fuel types considered here are oil, petroleum, gas and coal. Understanding the direction of causality is very important for policymaking to ensure sustainable development in energy sector. We do acknowledge the limitation of the bi-variate modelling here but rather our main focal point is untangled the causality interplay between these variables rather than considering the impact of other macroeconomics variables into the two-variables system. The remainder of the paper is organized as follows: Section 2 describes the data, methodology and empirical findings. Section 3 concludes the paper.

2. Data, Methodology and Empirical Findings

Annually data of energy supply (ES) over the period 1978-2010 was obtained from Malaysia Energy Information Hub (MEIH) provided by Energy Commissions. The four main domains of energy supplies are oil (OIL), petroleum (PET), gas (GAS) and coal (COAL). Data on GDP was taken from Department of Statistics Malaysia.

As the prelude to any cointegration and VAR (Vector Autoregression) testing procedure, the variables under investigation must be a stationary time series. For this purpose, we conduct one unit root [9] and one stationary test [10] on all the five series and their first differences. Results suggest the existence of unit root or nonstationarity in level or I(1) for these variables. Next we move to Johansen and Juselius cointegration test [11]. The null hypothesis of no cointegrating vector ($r = 0$) was soundly rejected at 5 percent level for the case of OIL and COAL, implying that the two variables do not drift apart and share at least a common stochastic trend in the long run. For the remaining energy domains, no long run relationship was detected.

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[1] According to the report of REN21[6], global demand for renewable energy continued to rise during 2011 and 2012. Renewable energy supplied 19% of global final energy consumption by the end of 2011, where approximately 9.3% came from traditional biomass. Useful heat energy from modern renewable sources accounted for 4.1% of total final energy use; hydropower made up about 3.7%; and an estimated 1.9% was provided by power from wind, solar, geothermal, and biomass, and by biofuels. These domains of renewable energy sources (RESs) were beyond the scope of the paper.

Results for VECM were portrayed in Panel A Table 1. First, short run causality were not detected between GDP and energy supply (OIL and COAL) in Malaysia. Second, the ECT is statistically significant where it is bear by GDP in both cases. Third, speed of adjustment stands at 1.03 percent per year in case of OIL and 2.08 percent per year in case of COAL due to the short run adjustments. So, this implies that Malaysia will need above 97 years (oil) and 48 years (coal) to adjust back to long run equilibrium. So, GDP functions as the initial receptor of any exogenous shocks that distort the equilibrium system in Malaysia. Fourth, the ECT result shows the existence of long run causality running from OIL and COAL to GDP. Fifth, results for VAR causality system were portrays in Panel B for which cointegration is absence. The results clearly show that the existence of short run unidirectional causality relationship running from GDP to PET and GAS.

Table 1: Causality Results

Energy Supply	**Dependent Variables**	**χ^2-statistic (p-value)**		**ECT**	
A: Vector Error Correction Model (VECM)					
		ΔGDP	**ΔOIL**	**Coefficient**	**-Statistic**
OIL	**ΔGDP**	-	0.1545(0.6943)	-0.0103**	-4.2233
	ΔOIL	1.9179(0.1661)	-	-0.0001	-0.0111
		ΔGDP	**ΔCOAL**	**Coefficient**	**t-Statistic**
COAL	**ΔGDP**	-	0.0112(0.9158)	-0.0208**	-4.1964
	ΔCOAL	0.5424(0.4615)	-	-0.0439	-1.6956
B: Vector Autoregression (VAR)					
		ΔGDP		**ΔPET**	
PET	**ΔGDP**	-		0.9299(0.3349)	
	ΔPET	5.2355**(0.0221)		-	
		ΔGDP		**ΔGAS**	
GAS	**ΔGDP**	-		0.6565(0.4178)	
	ΔGAS	4.4030**(0.0359)		-	

Notes: "Δ" is the first different operator. Asterisks (**) indicates statistically significant at 5 percent level.

In order to strengthen the empirical evidence from causality analysis, the dynamic analyses of Variance Decompositions (VDCs) are executed. Results of the VDCs (from 1 to 48 years for all the models) are given in Table 2. ES seems to be the most interactive variable in the system except for COAL where it explains nearly 40 percent of GDP in the end of 48 years horizon. For the rest of energy domains it suggest that the impact of GDP towards oil (28 percent), petroleum (6 percent) and gas (60 percent).

Table 2: Variance Decompositions Test Results

		Due to innovation		**Due to innovation**		**Due to innovation**		**Due to innovation**	
Percentage of variations in	**Horizon**	**GDP**	**OIL**	**GDP**	**PET**	**GDP**	**GAS**	**GDP**	**COAL**
GDP	1	**100.00**	0.00	**100.00**	0.00	**100.00**	0.00	**100.00**	0.00
	4	**99.13**	0.87	**97.03**	2.97	**97.48**	2.52	**99.85**	0.15
	8	**98.35**	1.65	**96.26**	3.74	**94.41**	5.59	**99.02**	0.98
	12	**97.49**	2.51	**96.01**	3.99	**92.75**	7.25	**97.44**	2.56
	24	**94.21**	5.79	**95.75**	4.25	**90.87**	9.13	**88.52**	11.48
	48	**85.58**	14.42	**95.63**	4.37	**89.95**	10.05	**60.56**	39.44
ES	1	13.56	**86.44**	2.04	**97.96**	0.85	**99.15**	3.82	**96.18**
	4	28.32	**71.68**	2.26	**97.74**	9.35	**90.65**	7.79	**92.21**
	8	30.05	**69.95**	2.81	**97.19**	23.28	**76.72**	7.55	**92.45**
	12	30.31	**69.69**	3.29	**96.71**	33.56	**66.44**	6.87	**93.13**
	24	29.86	**70.14**	4.46	**95.54**	49.34	**50.66**	4.86	**95.14**
	48	28.29	**71.71**	5.90	**94.10**	59.87	**40.13**	2.41	**97.59**

Note: The column in bold represent their own shock.

3. Concluding Remarks

Three major findings were summarized in this study. First, long run relationships are detected between GDP with OIL and COAL. Second, unidirectional causality running from GDP to PET and GAS in the short run while long run causality was detected running from OIL and COAL towards GDP. Third, VDCs supported that strong direct causality originating from GDP to all energy domains except COAL. In term of policy implementations, energy conservation policies that reduce energy in Malaysia will not hinder economic growth [12, 13, 14]. Government should carry out energy saving measures in which to reduce inefficiency or unnecessary wastage of energy that can smooth the path of economic growth. This could strike the balance of environmental concern, economic growth, sustainability and energy security for Malaysia.

Acknowledgements

The authors gratefully acknowledges financial support from Universiti Malaysia Sarawak (UNIMAS) Geran Penyelidikan Khas (Top Down) 03(TD04)/1054/2013(02). The usual disclaimer regarding errors and omissions applies.

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